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EDITORIAL

DURING the week set aside for campaigning in favor of the Red Cross, we have witnessed again the ready response of the Filipino people to an appeal for the support of a movement started primarily for the common good of mankind. The comparatively few pesos that we contributed to the cause may appear insignificant when measured by the standard of what wealthier nations have raised; but there was much in the prevailing spirit among our local donors which deserved commendation.

Every citizen considered it his patriotic duty to lend his aid to this great work; and it was always a matter of pride for anyone during the Red Cross Drive to wear a button or a tag bearing the red insignia. The wearer found a cause for satisfaction in the consciousness of having done something for the good of his fellow men, as well as in being aware that his contribution, no matter how modest, assists to speed onward the greatest errand of mercy the world has ever undertaken.

Field Tests of Soy Beans

By PEDRO LAYOSA Y MAKALINDONG

Thesis presented for graduation from the College of Agriculture No. 92.

Of the leguminous crops in the Philippines the soy bean is the only one of which the finished products are used. These finished products, the most important of which are the soy bean curd (*tahuri*) and soy bean sauce (*toyo*) have been long known all over the Islands. In spite of this evidence of its economic importance, the crop has been given but very little attention by the Filipino farmers.

The soy bean is one of the chief sources of food in many Asiatic countries, particularly in China, Japan and Korea. In the battle fronts of Western Russia the Russian armies in the Great War used soy beans as a substitute for meat when it became scarce. An issue of the National Geographic Magazine (1) reports an enormous exportation from Japan of thousands of sacks of soy beans destined for this purpose.

The following table shows the constituents of soy beans as analyzed by the Philippine Bureau of Science: (2)

Constituent	Per cent
Water.....	9.84
Protein.....	37.53
Fat.....	18.97
Nitrogen-free extract.....	—
Crude fiber.....	—
Starch.....	—
Ash.....	4.79
Nitrogen.....	5.99
SO ₂ per cent in ash.....	1.4
Oil refraction in Zeiss Butyro scale at 30°.....	81.0
Iodine number Hanus.....	66.3

As shown in the preceding table the soy bean is particularly rich in protein, and this may account for its widespread use in China, Japan, and other places and for its growing popularity among the nations at war. The various recipes made from soy bean are of Oriental origin. The soy bean milk, bean cheese, and soy bean sauce are three Japanese preparations made especially from this bean. Bread and bis-

cuits from soy bean are now placed on the European markets. As the soy bean contains little or no starch, it is much used by diabetic patients. Roasted soy beans, a good substitute for coffee, is now being used for adulterating coffee and cacao. The oil expressed from the soy bean is not only used for food but also for many other purposes. Korentschewski and Zimmermann, in 1906, studying the digestibility of the soy bean oil, found its coefficient of digestion for man to be about 95 per cent showing that it is readily assimilated. In China, it is used for illuminating purposes. As the oil has a drying property, it can be used as a substitute for linseed oil in the manufacture of paints. In Europe and Eastern Asia it is being used in the manufacture of soap and as a machine lubricant. In addition to its use as food, the use of the soy bean as forage, as green manure, and as a soil renovator has long been recognized by countries that have grown this legume.

The soy bean does not require more attention than its allies, *Phaseolus mungo*, *Phaseolus vulgaris* and *Dolichos lablab*. More than some of its allies, the soy bean has been observed to resist the most adverse local conditions such as faulty cultivation and manuring, inadequate care, etc.

Although the college had been planting the soy bean from the start, no real step was taken towards its improvement as a field crop until last year, when Gregorio F. Grageda, a thesis student, started a rigid selection of pure cultures. Out of the several varieties which he tested two proved to be of possible future value as superior yielders of both bean and forage and also in adaptability to cropping more than once a year. Grageda made consider-

able initial selection and began to multiply some of the superior individual plants, thereby producing enough materials for continuing the work he started. The object of the present work was to put these selections started under tests on as large a scale as possible with the materials started by Grageda.

SOIL SUITABLE FOR SOY BEAN

The soy bean does well in light soils; but if this crop is to be grown on clayey land, the soil must be well worked up. As a general rule, soil that will grow corn successfully is also adapted to the soy bean. In soil rich in organic matter the soy bean tends to produce an abundance of foliage with fewer seeds, making the plants hard to cure for hay purposes. Again, very wet soil is objectionable to successful seed production as the seeds rot easily, resulting in a large percentage of diseased seeds with a low percentage of germination. It is, therefore, necessary to choose well aerated land of medium fertility. The soy bean can be successfully grown on dry land and, according to the writer's observations, it can withstand very dry weather.

The soy bean is a nitrogen gatherer through the medium of the root tubercles. Nodules in the roots were observed by the writer in plants a month or less old. This fact should be taken into consideration when fertilizers are to be used in growing the soy bean. Application of fertilizers containing nitrogen is not advisable while application of those rich in acid phosphate and potash have proved to be satisfactory. The following formula to be applied per acre is recommended by the Agricultural Experiment Station, University of Tennessee:

Acid phosphate.....	300 lb.
Wood ashes.....	250 lb.
or Muriate of potash.....	25 lb.

In localities where wood ashes and muriate of potash cannot be had, the

same authority recommends the use of acid phosphate alone; a fair amount would be 200 to 300 pounds per acre; it should be well worked into the soil before planting. Land which is sour can be corrected through liming. As with other crops, farm yard manure can also be used on a soy bean field.

The land for soy beans can be prepared in the same way as land for corn. Plowing must be done early in the dry season with a gang plow, and the disc harrow may be used to break up the big clods, which in most cases retard seed germination, to destroy weeds and to produce soil mulch. The presence of an adequate soil mulch is very important, especially in the dry season. Two or three subsequent plowings are all that are necessary, after which the field is again disc-harrowed. Where the soil has been cultivated for a long time, only one plowing and one harrowing are necessary. Planting must be done as early as the land is prepared because weeds are bothersome if allowed to grow ahead of the crop.

CULTURE

The method of planting soy beans depends very much upon the purpose for which the crop is grown. When grown for forage or for green manuring, the seeds can be broadcasted. In this case the plants are stunted. The objections to this method are that the plant cannot be cultivated with the animal; and the amount of seeds sown per unit of area is very great.

For seed production the best method is to plant in rows. The rows can be set from 50 to 75 centimeters apart, depending upon the variety. The bigger variety, as, for example, the Ami's bean, can be planted at distances of 75 centimeters between the rows and 50 centimeters in the row; with smaller varieties, such as Kedilcie Wit, 75

centimeters between the rows and 30 to 50 centimeters apart in the rows are sufficient. The distancing can be reduced for dry-season cultures especially in the case of the Kedilcie Wit variety which does not grow large. But in order to facilitate cultivation with the vaca cultivator the distance between the rows must not, in any case, be less than 75 centimeters. Two to three seeds may be planted in each hill for general purposes but in selection work, for convenience, the plants must be thinned to one. If production is on a big scale, seeds can be planted at less expense by means of a seed driller. There is no driller especially adapted to this purpose, but the common corn planter can be adjusted and used to advantage. Planting with a seed drill is very much faster than by hand, besides the further advantage that the making of the rows by furrowing is dispensed with. Furrows can be made with the hand plow if planting is done on a small scale. In planting the seeds in rows, the depth to which the seed is planted is very important. During the rainy season, seeds must not be planted too deep, for the soil becomes compact around the seeds and tends to retard germination, very frequently resulting in the rotting of the seeds, which because of their nitrogenous nature are very susceptible to decay. A depth of 1 to 2 inches is all that is necessary under ordinary conditions. In dry season seeds must be planted deeper and the soil pressed around them so as to keep the supply of moisture; otherwise in this case, also, germination will be retarded.

Soy beans can be intercropped with corn, rice and other cereals. In the United States and in Japan planting soy beans with corn is extensively practiced; this could undoubtedly be done in the Philippines also. In this case,

two crops are secured at the same time besides the deposition in the soil by soy beans of extra amounts of nitrogen, the most expensive constituent of plant food. In connection with the chemical constituents of the soy bean, the Connecticut Agricultural Experiment Station at Mount Carmel has given out the following interesting data as to the amount of substances turned into the soil per acre from an average crop of soy beans exclusive of roots:

Organic matter.....	4,225 lb.
Nitrogen.....	131 lb.
Phosphoric acid.....	23 lb.
Potash.....	93 lb.

The data clearly shows that of the three important fertilizers, nitrogen, potash and phosphorus, likely to be deficient in the soil, nitrogen is supplied by soy beans in quantities greater than the other two combined.

The soy bean can be cultivated in much the same way as corn or any field bean. When seeds are planted in rows, the ordinary vaca cultivator can be used. In a well prepared field, for early varieties, cultivation is done two or three times only during the development of the crop, but for late growing varieties more cultivation is necessary. After the plants have blossomed and pods have begun to form, only occasional weeding is necessary. Weeds must be kept down from the start to avoid further trouble at the later stage of the crop. The writer has experienced this trouble when labor was scarce and especially during the rainy season when cultivation was impossible because of excessive rain.

HARVESTING

The time of harvesting depends upon the use for which the crop is intended. When intended for forage, the plants must be cut when the pods are half developed or even before this time.

At this stage the stems are comparatively soft and most of the leaves adhere to the stem; it is believed that the crop is then very palatable and the digestible nutrients greater than when more matured. When the crop is intended for seed, the change of color from green to brown on the leaves is a good indication that the crop is ready to harvest. Care must be taken to harvest the plants in time, as over-ripe pods will burst open, causing a considerable loss in seeds. The plant can be pulled by hand or cut with a scythe. Gathering the pods by hand is very uneconomical of labor and should not be practiced except in cases where help can be had cheap. When the plants are to be harvested by machinery the pods can be left till very brown. In addition to these methods of harvesting, hogging down soy bean is another method practiced in the hogbelt of the United States. By this method the cost of harvesting is eliminated and the crop is turned into meat, a finished product of more profitable returns.

THRESHING AND STORING

After harvesting, the plants must be piled and allowed to dry in an open place. When dried the leaves fall off. The plants can then be beaten or put in sacks and flailed, after which the seeds can be cleaned by means of sieves. The common native sieve is very effective. The winnowing machine can be used also for cleaning. Drying the pods under the hot sun facilitates threshing, as the pods break off and shed the seeds readily. There is an objection to this latter method, as the testa of the seeds break, thus exposing the seeds to deterioration. The bean- and pea-huller has been found very effective in this college. A 2-h. p. motor was used to run it. One tenth hectare plantation can be threshed within 1 1/2 hours.

Only a very small proportion of the pods are left unhulled and these can be flailed in a sac.

CURING AND STORING SEEDS

Sacks containing seeds should not be piled one on top of the other because the circulation of the air will be checked and this injures the vitality of the seeds. Well cured seeds are less susceptible to the attack of beetles. Seeds intended for storage for some time previous to planting should be mixed with naphthalene or charcoal in order to guard against the attack of beetles.

NOTES FROM GRAGEDA'S WORK

Grageda planned to use individual selection as his basis for improving the seed production of soy beans by isolating the highest producing individuals. He started growing all the varieties introduced into the college with a view of developing distinct cultures for rainy and dry season of each variety, so that there may be dry-season seeds and rainy-season seeds. The best individuals from each variety were selected right in the field and pure cultures started from each. The adaptability of a single variety or of a single strain to given conditions was also to be determined. Individual varieties and strains within a variety found to do best in the wet season were to be selected for that season, and in a like manner for dry season. But as Grageda found that most of the available seeds had lost their vitality in storage, it was decided to plant them all at once in one-season culture. Out of the five varieties, one native and four foreign, two came out with good results. These are the Kedilcie Wit bearing the college number 3905 and the Ami's bean, college number 217. The first one is from Java and the last is a native soy bean. From his initial planting made in the latter

part of January a few pods, most of which came out empty, were harvested March 3. Those planted during the month of February, except Plots 130, 38, and 210, matured their seeds by June 10. (Note: This method of naming pure or individual cultures by citing the number of plots where they were grown is Grageda's own method and it is herein repeated for the sake of correlation.) These plots did not produce any seeds at all. So the same plants were carried over an unusually long period of growth until October. The plants developed heavy foliage and a fairly good harvest was obtained for the second time. In this particular instance the seeds from the first harvest were added to those of the last, making up the total yield of a single crop practically over two planting seasons. The Kedilcie Wit is the earlier maturing of the two successful varieties, the growing period covering only about 90 days. The one that ran over nearly two seasons was the Ami's variety. The unusual behavior of this variety was undoubtedly due to the fact that it was planted late during the second planting season of the year. When it came to flowering stage, which was at the height of the dry season, there was not enough moisture in the soil to induce the normal formation of seeds. Instead of drying out, however, they went on flowering and producing seeds after the crops had the benefit of the wet season of the year. Under normal conditions, this variety requires only from three to four months for its complete development.

The yield obtained from one plant and the average yield per plot in Grageda's work showed a good result in the selection of seeds. An average of 8 tons (short ton) of seeds or approximately 7272 kg. of Ami's bean may be produced from individually selected stock, while the computed yield of a

plot of an area of 50 sq. m. averages from 104 to 663 kg. per hectare. This result of the plots compares very poorly with those of selected individuals. It is stated by Grageda that the plants grown from common stock seeds did not show uniformity, giving as a result a very low yield. This emphasizes the fact that by simply planting seeds continuously from a single variety without practicing a rigid selection, the progeny will not give such uniformity as is concomitant with high production. Comparing Grageda's average yield per hectare with results from other countries, the following table shows that his yields are very low:

United States.....	4500 kg.
Japan.....	3600 kg.
India.....	1160 kg.
Grageda's results.....	383 kg.

Grageda's yield of 383 kg. is about 1/15 of the yield of the United States, 1/4 of that of India and about 1/10 of Japan. It is of course unfair to compare his yield with the average in the three countries mentioned above; for we should also consider the fact that the cultivation of this crop has been long established in those parts of the world, while the work conducted by Grageda was but practically the beginning of a hitherto unattempted series of experiments.

PLAN OF THE WORK

The present work had for its objects:

1. The multiplication of the strains selected by Grageda and the running of head-to-row tests of the finest individuals or of elites under each strain.
2. To find out whether these strains, when multiplied under Philippine climatic conditions, will be of commercial value.
3. To find out which strains can be recommended for rainy season and which for dry season under local conditions.

The work is strictly the continuation of Grageda's work. The general plan was to divide the seeds from each strain into two lots, one for rainy-season and the other for dry-season culture in order to find the adaptability of certain strains for each season; but this plan was not carried out because of insufficient material. The amount of seeds produced by Grageda was so small that it was not found advisable to follow the above plan. It was therefore decided to plant all the strains for the rainy season and then set aside part of the product of these rainy-season strains for dry-season test. With the Kedilcie Wit this was done because of lack of sufficient seeds for dry and rainy seasons. As the Ami's bean had a sufficiently large quantity of seeds produced, some of the strains were planted for the rainy season and the rest for the dry season. The product of the rainy-season cultures will hereafter be designated "rainy season cultures" and the product of the dry-season cultures, the "dry season cultures."

RAINY-SEASON CULTURES

1. Kedilcie Wit.

The performance of this variety during the rainy season is as follows:

First planting, May 29, 1917. Five multiplication plots and fourteen élites of Kedilcie Wit produced by Grageda were planted. The five multiplication plots bear the following numbers:

3905 F₂ Kedilcie Wit, containing the strains 1 (P2), 2 (P5), 3 (P6), 4 (P7), 5, (P8.)

With this culture a common stock was also run.

The bracketed numbers are the former numbers given to different strains of Kedilcie Wit, College No. 3905 F₂ by Grageda. The new numbers were given by the writer. Grageda's numbering is retained with the new

numbers for the purpose of reference. It was found convenient to give the new numbers for the sake of simplification.) The élites handed over to the writer by Grageda did not germinate. The reason for this was probably the fact that he put the élite seeds in tight bottles before they were perfectly cured, which procedure the writer found to reduce the vitality of soy bean seeds. Unlike the élites, the seeds for the multiplication plots were stored in paper bags and found perfectly viable. Each of these plots scored 100% germination and the stands of the plants were very uniform. The plants were above the ground four days after planting. Following the advice of Grageda the distance given was 50 centimeters x 50 centimeters. But this distance was found inconvenient as the vaca cultivator could not pass between the rows without injuring the plants. Seventy-five centimeters between the rows and 50 centimeters in the rows was found to be the best distance. Three plants in each hill were left as the best stand for multiplication plots. At the start there was plenty of rain and this gave a good chance for the plants to develop well. The plants were found highly resistant to storm as well as to heavy rain. Early in the development of the plants, wilting set in. Sometimes as many as 20 or 15 plants a day would be found wilting, with leaves turning yellow and the plants would soon die. Professor Reinking who made observations on the diseases on the cultures said that fungus as well as insects were attacking the plants under the ground. When flowering started, July 12, 1917, about one and a half months after planting, the disease seemed to have disappeared and evidence of attack by either disease or insect was not seen thereafter.

Table I shows the results obtained from the multiplication plots. The yield

per hectare is computed in terms of the number of plants in each plot, distance of planting, and dry weight of seeds secured. The table shows clearly that with a careful eye to selection and with proper culture, the yield of the selected plants can be doubled or tripled. The table also shows the yield either of the parent or of the common stock. Strain 3 (P4) is the highest yielder, giving a computed production of 460.0 kg. per hectare. This yield is greater by 259.6 kg. than the common stock and 287.0 kg. greater than the parent. Next in superiority of yield comes 4 (P7) with 444.4 kg. per hectare. This is again 234.0 kg. more than the common stock and 254.4 kg. more than the parent. It is remarkable to note that in this particular case the common stock had a higher yield than the parent numbered 4 (P7.) This may be explained by the fact that these strains are better adapted to local conditions, 1 (P2) gives a yield of 374 kg. per hectare, or 218.0 kg. greater than the parent and 163.6 kg. greater than the common stock. The offspring of the other two strains 2 (P5) and 5 (P8) were a little superior in yield to their parents. Their yields were 19.2 kg. and 187.6 kg. greater than that of the common stock. These five strains should be tested further in the next planting seasons in order to ascertain whether they come true to type. The yield of the fresh forage can not be given in this connection for the harvesting was done after the pods were mature and most of the leaves had dropped off. The dropping of the leaves at the stage of maturity is characteristic of the two varieties tested. This, of course, lessens the weight of the dry forage but the leaves add organic matter to the soil.

Estimates of the dry forage showed as high as 2000 to 3000 kilos per hectare with only a few of the leaves. Those

estimates were calculated in terms of the dry weight of the plants. Dried forage is not so extensively used as fresh, but in certain parts of the United States, the dried plants after the seeds are removed are fed as dry forage to cattle and other live stock.

2. Ami's Variety.

The following were the cultures made during the rainy season for Ami's variety:

Multiplication plots:

Planted Sept. 15, 1917.

217 F₇ containing the following strains:

1 (P210-N1), 2 (P210-N2), 3 (P210-N3), 4 (P210-N4), 5 (P210-N5), 6 (P210-N6), 7 (P210-N3), 8 (P210-N8), 9 (P210-N11), 10 (P210-N12), 11 (P210-N13), 12 (P210-N38), 13 (P210-N35), 14 (P210-N27).

Planted Sept. 19, 1917.

217 F₇ containing strains:

15 (P1-N27), 16 (P130-N62), 17 (39-N23).

Planted July 20, 1917.

217 F₃ containing strains:

1 (P₆), 2 (P₃).

Common stock was run together with these multiplication plots.

The last two multiplication plots were previously run by Maximo Canonizado, student assistant in agronomy last year, and the seeds were turned over to the writer by the Department of Agronomy when the present thesis was begun.

Planted July 21, 1917.

Élite Cultures.

217 F₄ containing individual strains:

1 (N6), 2 (N7), 3 (N8), 4 (N9), 5 (N10), 6 (N11).

These élites were selected by Canonizado also. General stock was also run with these élites to provide comparison.

The cultures were subjected to the most adverse conditions, for drought prevailed at the beginning of the season and excessive rainfall during the middle part of the season. The land was flooded once and as a consequence was

badly washed off. The ground then remained wet almost a month making it impossible to cultivate. When flowering time came, many of the flowers were destroyed because of continuous rains.

Table III shows the results obtained from the multiplication plots. Upon examination of the table we find that 6 out of 14 strains of Grageda's plot numbered 210 gave a higher yield than their respective parents. Plot 16 (P130-N62) and 17 (P39-N23) also gave a higher yield than their parents. The two plots of Canonizado and 17 (P39-N23) of Grageda came below their parents in yield. Comparing the results with the common stock we see that only 2 of Grageda's plot, numbered 210, came below the common stock yield. Strain 15 (P1-N27), and the two plots of Canonizado gave higher yields than the common stock. Strain 16 (P210-N62) came below the common stock yield. Strain 12 (P210-N38) gave the highest yield, 193.86 kg. computed per hectare, which is 86.00 kg. above the yield of the parent and 78.53 kg. above the common stock yield. Next in yield came strain 14 (P210-N27) giving a yield of 201.60 kg. per hectare, or 84.00 kg. over the parent and 75.67 kg. over the common stock. Here again it may be noted that the common stock yielded higher than the parents of each of these strains. The explanation that can be offered for this discrepancy is the same as in the case of Kedilcie Wit cultures. 13 (P210-N35) the third highest in yield gave a yield of 150.67 kg. per hectare or 73.34 kg. over the parent and 25.14 kg. over the common stock. All the yields over the parents marked with minus signs should be discarded for the next planting because their yield proved inferior to that of the parent, while those with positive signs should be continued for the next planting season

to see whether they will come true to type. As to dry forage, only an average of 1066 kg. per hectare was secured. This is rather low when compared with the yield of the Kedilcie Wit, especially as Ami's bean is a larger variety than the Kedilcie Wit. The low yield in forage is partly accounted for by the fact that harvesting was done rather late owing to heavy rains, so the stems were rotting and the leaves had fallen off.

Table II shows the yield of the elite cultures. Four out of the 6 strains gave yields superior to the parents. They all surpass the yield of the common stock. Strains 3 (N7) gave a yield of 471.73 kg. per hectare, or 71.74 kg. over the parent and 231.74 over the common stock. The other two strains 4 (N9) and 5 (N10) must be tested further in the next planting season while the two strains 1 (N6) and 6 (N11) should be discarded for future planting because their performances are inferior to those of the parent. Computation of dried forage showed only 1333.33 kg. per hectare for the highest individual.

DRY-SEASON CULTURES

The response to cultures of the seeds from the "rainy-season cultures" of the variety Kedilcie Wit, College Number 3905 F., when planted during the dry season is as follows:

One half of the seeds from the strains 1 (P2), 2 (P5), 3 (P6), 4 (P7), were separated and used for the dry-season cultures. Seeds were not secured from the rainy-season culture of strain 5 (P8) because the seeds produced were not sufficient to run a multiplication plot. They were planted October 31, November 13, November 16 and November 16, 1917, respectively. Three plants were left in each hill. The distance of 75 cm. x 50 cm. was used. It was found that the plants were

stunted, developed poor foliage, and flowered earlier than the rainy-season cultures. The crop also matured earlier, taking only 2 ½ months on the average, from the date of planting to the time of harvesting. While the plants in the wet season averaged a height of from 1½ to 2 feet, the dry season plants reached only a height of from 20 cm. to a foot with fewer stems and pods.

Table IV shows the results obtained from this culture. It shows a relatively poor yield as compared with that of the rainy-season cultures. Strain 1 of the dry-season cultures gave 195.62 kg. per hectare, which is 178.38 kg. less than the yield of the parent, but is 139.63 kg. greater than the yield of the common stock cultures. Strain 2 gave a yield of 98.93 kg. per hectare, which is 140.67 kg. less than the parent, but is 42.98 kg. greater than the common stock. Strains 3 and 4 gave 72.13 kg. and 78.66 kg. per hectare respectively. The first was 387.87 kg. less than the rainy-season culture, but is 16.14 kg. greater than the common stock yield, while the second one is 365.78 kg. less than the rainy-season culture but is 22.67 kg. greater than the common stock. The cultures show that, although the cultures of the dry season were very much inferior to those of the rainy-season cultures, their yield was superior to that of the common stock.

AMI'S BEAN IN DRY-SEASON CULTURES

The dry-season cultures of this variety consist of 44 strains, all of which were run in multiplication plots. These cultures are as follows:

Planted October 16, 1917.

217 F₇ containing strains 18 (P5-N9), 19 (P5-N10), 20 (P5-N11), 21 (P5-N12), 22 (P29-N12), 23 (P29-N13), 24 (P40-N30), 25 (P40-N36), 26 (P40-N33).

217 F₆ containing strains 1 (P6-N6), 2 (P7-N1), 3 (P7-N2), 4 (P7-N3), 5 (P7-N4), 6 (P32-N8), 7 (P32-N9), 8 (P32-N10).

Planted October 22, 1917.

217 F₆ containing strains 9 (P80-N16), 10 (P80-N17), 11 (P80-N18), 12 (P80-N19), 13 (P80-N19), 14 (P80-N21), 15 (P80-N22), 16 (P80-N23).

Planted October 29, 1917.

217 F₆ containing strains 17 (P100-N2), 18 (P100-N3), 19 (P100-N4), 20 (P100-N5), 21 (P100-N6), 22 (P100-N7).

Planted October 21, 1917.

217 F₆ containing strains 23 (P108-N24), 24 (P108-N5), 25 (P108-N6), 26 (P108-N17), 27 (P107-N3), 28 (P107-N4), 29 (P107-N7), 30 (P38-N29).

217 F₇ containing strains 27 (P138-N13), 28 (P138-N14), 29 (P138-N15), 30 (P138-N18), 31 (P138-N22).

General stock culture was run at the same time with these multiplication plots.

Forty-two élites selected by Grageda were planted but none of them germinated. Like the élites of the Kedilcie Wit, they apparently lost their vitality because of improper curing.

All of the strains run in multiplication plots, however, gave a very uniform stand in spite of the fact that after planting it was dry throughout the seasons. No attention was given to these cultures except a little cultivation and cutting down of big weeds. Harvesting was done after 3½ months or about ½ month earlier than with the rainy-season culture. Each plant was heavily loaded with pods, each bearing from 2 to 3 seeds. Because of the heavy load of pods, most of the plants could not hold themselves erect and consequently lay flat on the ground. At harvesting time the leaves had all fallen from the stems and the pulling of the plants, which is the cheapest method of harvesting soy bean, was therefore comparatively easy. The plants were mostly dry and the threshing of seeds by flailing was also easy.

Table V shows the results obtained from the preceding cultures. It is

remarkable that 34 strains, out of the 44 tested, gave a yield above that of the respective parents, and only 29 of these 44 strains scored yield over the general stock. The highest yield was obtained from 29 (P138-N15) of 217 F₇, 990.933 kg. of seeds per hectare being secured. This means a yield of 838.86 kg. above the parent and 772.33 kg. above the yield of the common stock, or an increase of 521% over the parent and 236% over the common stock. Next in superiority of yield was 29 (P107-N7) of 217 F₆, 766.933 kg. per hectare. This again is 659.2 kg. higher than the parent and 500.07 kg. higher than the general stock. The results given in Table V of the multiplication strains with a minus before the yield figures indicate that this particular strain was below the average and their seeds must go back to common-stock culture.

The results so far obtained from all the cultures made, show that selection would be of considerable advantage to the farmer. Through continuous selections of the best and elimination of the undesirable strains we may find strains that are in all respects superior and thus we may obtain the highest possible yield under local conditions.

The dry forage obtained from the dry-season cultures with both varieties tested shows that it is correlated with the dry weight of the seeds obtained. This does not, however, hold true with the rainy-season cultures. These cultures show that the amount of seeds obtained is very small compared with the forage.

CONCLUSIONS

1. The test continuing through two years, the first year by Grageda and the second year by the writer, of individually selected seeds of soy beans of both varieties, Kedilcie Wit and Ami's bean,

shows that the seed production can be greatly increased.

2. So far, the Ami's bean gave a higher yield of seeds per unit of area than Kedilcie Wit.

3. The strains that came true to type are up to the present experiments greater in number than the strains that did not. See Tables I and V. Strains of the Kedilcie Wit, 3 (P6), 5 (P8), 1 (P2), of 3905 F₂, grown during the rainy season (Table I), and strains 29 (P138-N15) of 217 F₇, 29 (P107-N7) of 217 F₆ of the Ami's variety grown during the dry season (Table V) proved the highest yielders in all the cultures made.

4. So far as Kedilcie Wit is concerned, a one-year test has proved that seeds obtained from the rainy-season culture and grown for the dry season gave a comparatively lower yield than that obtained during the rainy season.

RECOMMENDATIONS

1. Selections must be carried on more extensively to find the highest yielders, disease-resistant strains, and strain for dual purposes of both forage and seed.

2. The highest-yielding strains should be further tested until they have proved true to type.

3. Fertilizers, either natural or commercial, should be applied to determine how the soy bean will respond to fertilization.

4. The soy bean is not generally known in the Islands. Therefore its planting should be encouraged by introducing as widely as possible seeds that have been carefully tested and found to be the best for local conditions.

5. Different foreign varieties should be imported and subjected to test and acclimatization in a more comprehensive manner than heretofore.

6. A study of methods of curing and storing of soy bean seeds should be undertaken with the view of finding the best methods for local conditions.

ACKNOWLEDGMENT

The writer wishes to express his thanks to Assistant Professor Inocencio Elayda for his valuable assistance and criticism throughout the progress of the work.

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(See Tables I to V, pp. 287 to 291)

TABLE I
KEDILCIE WIT MULTIPLICATION PLOTS, RAINY-SEASON CULTURES

	PARENTS						OFFSPRING						
College Number	Total Wt.	P of Plants	N umber of Plants	W eight of Seeds	Compu ted Yield per Hectare	Date Planted	Date Harvested	Total Wt. of Plants	N umber of Plants	W eight of Seeds	Compu ted Yield per Hectare	Gain over Parent	Gain over Common Stock
3905 F ₂	kg.			kg.	kg.	May 25, '17	Sept. 18, '17	kg.	696	4.17	374	kg.	kg.
1 (P2).....	.74	41		.16	156	"	"	56				218	163.6
2 (P5).....	.23	12		.06	200	"	"	22.5	359	3.47	239.6	39.6	19.2
3 (P6).....	.48	23		.10	173	"	"	32.0	587	6.76	460.0	287.0	259.6
4 (P7).....	.55	23		.11	190	"	"	18.3	297	3.30	444.4	254.4	234.0
5 (P8).....	.56	29		.28	386	"	"	14.0	210	2.09	398.0	12.0	187.6
			Common Stock					39.3	500	2.63	210.4		

TABLE II
PERFORMANCE OF THE AMI'S BEANS, ELITES

College Number	PARENTS				OFFSPRING							Gain over Common Stock
	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Date Planted	Date Harvested	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Gain over Parents	
217 F ₄	kg.		kg.	kg.	July 21, '17	Nov. 20 '17	kg.	26	.46	471.73	kg.	kg.
1 (N6).....	.070	1	.020	533.33			.73				—61.60	231.74
2 (N7).....	.080	1	.015	399.99	"	"	1.52	52	.92	471.73	71.74	231.74
3 (N8).....	.070	1	.010	266.67	"	"	1.06	35	.66	426.27	160.00	186.26
4 (N9).....	.090	1	.020	533.33	"	"	2.2	44	.93	563.47	30.14	323.48
5 (N10).....	.090	1	.015	399.99	"	"	.71	24	.41	455.46	55.47	221.47
6 (N11).....	.080	1	.020	533.33	"	"	1.13	41	.65	426.66	—106.67	186.67
		Common stock			"	"	.93	50	.45	239.99		

TABLE III
AMI'S BEANS MULTIPLICATION PLOTS. RAINY-SEASON CULTURES

College Number	PARENTS				OFFSPRING							
	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Date Planted	Date Harvested	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Gain over Parent	Gain over Common Stock
217 F ₇	kg.		kg.	kg.			kg.		kg.	kg.	kg.	kg.
1 (P210-N1).....	3.4	94	.88	249.49			6.8	251	1.36	165.60	-83.89	40.27
2 (P210-N2).....	3.6	108	.95	233.44			8.0	261	1.64	167.47	-65.97	42.14
3 (P210-N3).....	4.2	150	1.11	197.33			7.8	320	1.78	148.47	-48.86	23.14
4 (P210-N4).....	3.2	119	0.67	150.13			7.8	301	1.76	145.07	-5.06	19.74
5 (P210-N5).....	2.4	105	.67	170.13			6.6	340	1.5	117.6	-52.53	-7.73
6 (P210-N6).....	3.98	136	1.0	196.0			7.2	212	1.62	203.73	7.73	78.40
7 (P210-N7).....	4.98	215	1.24	153.79			7.8	360	1.44	106.67	-47.12	-18.66
8 (P210-N8).....	3.37	118	.89	201.06			10.0	312	1.87	159.73	-41.33	34.40
9 (P210-N11).....	4.53	222	1.21	141.33			9.6	340	1.83	143.73	2.40	18.40
10 (P210-N12).....	3.25	92	.76	191.20			9.0	381	2.0	151.20	-40.00	25.87
11 (P210-N13)...	3.14	167	.69	110.13			7.8	276	1.6	156.27	46.14	30.94
12 (P210-N38)...	3.53	177	.71	106.93			7.8	205	1.49	193.86	86.93	68.53
13 (P210-N35)...	4.06	293	.85	77.33			8.2	330	1.86	150.67	73.34	25.34
14 (P210-N27)...	3.51	172	.76	117.60			17.0	432	3.27	201.60	84.00	76.27
15 (P1-N27).....	1.83	107	.39	96.7			9.4	281	1.48	140.27	44.57	14.94
16 (P130-N62)...	3.36	237	.81	90.93			17.4	610	2.67	116.53	25.60	-8.80
17 (P39-N23)....	3.0	210	.92	121.866			13.1	481	1.63	90.40	-31.47	-34.93
217 F ₃												
1 (PIII).....	2.64	149	1.04	186.13			5.2	330	1.83	147.73	-38.40	22.40
2 (PVI).....	2.64	149	1.44	257.599			13.0	531	3.94	187.73	-69.86	62.84
		Common Stock										
							6.3	282	1.34	125.33		

TABLE IV
KEDILCIE WIT MULTIPLICATION PLOTS. DRY-SEASON CULTURES

College Number	PARENTS					OFFSPRING						
	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Date Planted	Date Harvested	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Gain over Parent	Gain over Common Stock
3905 F ₃	kg.		kg.	kg.	Oct. 31, '17		kg.		kg.	kg.	kg.	kg.
1.....	56	696	4.17	374.0*	Oct. 31, '17	Jan. 28, '18	16.6	1320	9.7	195.62	-178.38	139.63
2.....	22.5*	359	3.47	239.6	Nov. 13, '17	Feb. 8, '18	6.6	1025	3.81	98.93	-140.67	42.94
3.....	32.0	587	6.76	460.0	Nov. 17, '17	"	9.4	1296	3.61	72.13	-387.87	16.14
4.....	18.3	297	3.30	444.4	Nov. 17, '17	Feb. 10, '18	8.2	1100	3.25	78.66	-365.78	22.67
		Common Stock.			"	"	3.2	560	2.10	65.99		

TABLE V
AMT'S BEANS MULTIPLICATION PLOTS. DRY-SEASON CULTURES

College Number	PARENTS					OFFSPRING						
	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Date Planted	Date Harvested	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Gain over Parent	Gain over Common Stock
217 F ₇	kg.		kg.	kg.			kg.		kg.	kg.	kg.	kg.
18 (P5-N9).....	2.96	141	.74	139.73	Oct. 16, '17	Feb. 4, '18	2.0	200	.97	129.33	-10.40	-137.53
19 (P5-N10).....	3.78	150	.85	150.93	"	"	1.6	203	.85	111.46	-6.47	-155.40
20 (P5-N11).....	3.49	145	.82	150.67	"	"	3.8	268	1.21	119.99	-30.67	-146.87
21 (P5-N12).....	4.07	154	1.09	188.53	"	"	3.6	310	1.63	142.99	45.54	-123.87
22 (P29-N12).....	2.24	130	.49	100.27	"	Feb. 6, '18	6.0	490	2.28	124.666	24.397	-142.19
23 (P29-N13).....	2.14	114	.46	107.47	"	"	8.2	403	4.08	269.866	162.396	3.006
24 (P40-N30).....	3.06	140	.77	146.47	"	"	2.6	314	1.09	92.533	53.937	-174.327
25 (P40-N36).....	3.04	198	.75	100.80	"	"	1.4	175	.67	99.19	-1.62	-167.76
26 (P40-N33).....	1.69	114	.27	62.93	"	"	5.6	414	2.97	191.19	128.26	-75.67
27 (P138-N13)...	5.04	231	1.27	146.399	Oct. 31, '17	Jan. 28, '18	16.8	403	7.96	525.55	378.151	258.69
28 (P138-N14)...	3.08	131	.91	185.066	"	"	9.6	330	7.99	751.466	566.40	484.606
29 (P138-N15)...	5.07	197	1.19	161.066	"	"	15.4	215	7.99	990.933	838.867	732.47
30 (P138-N18)...	1.88	148	.29	41.066	"	"	8.0	230	3.88	449.866	408.8	183.006
31 (P138-N22)...	3.36	237	.81	99.199	"	"	6.6	336	3.44	281.066	181.876	14.206
217 F ₆												
1 (P6-N6).....	1.79	90	.44	130.13	Oct. 16, '17	Feb. 4, '18	1.2	130	.53	107.53	-22.60	-159.33
2 (P7-N1).....	5.24	218	1.38	168.80	"	"	7.6	515	3.92	202.66	33.86	-64.20
3 (P7-N2).....	3.52	125	.91	194.13	"	"	8.8	465	4.35	247.99	53.86	-18.87
4 (P7-N3).....	3.14	125	.93	198.40	"	"	6.8	349	3.47	257.33	58.93	-9.53
5 (P7-N4).....	3.53	132	1.04	209.87	"	"	2.2	210	1.22	154.66	-55.21	-12.20
6 (P32-N8).....	4.28	167	1.23	196.27	"	Feb. 6, '18	12.6	536	6.79	337.599	141.32	70.739
7 (P32-N9).....	4.79	203	1.27	166.67	"	"	11.0	400	5.47	364.533	197.86	97.673
8 (P32-N10)....	5.04	145	1.26	231.47	"	"	7.4	307	3.35	296.533	65.06	29.673

TABLE V
AMT'S BEANS MULTIPLICATION PLOTS. DRY-SEASON CULTURES.—Cont'd.

PARENTS			OFFSPRING									
College Number	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Date Planted	Date Harvested	Total Wt. of Plants	Number of Plants	Weight of Seeds	Computed Yield per Hectare	Gain over Parent	Gain over Common Stock
9 (P80-N16)....	3.47	125	1.12	238.93	Oct. 22, '17	Jan. 28 '18	10.0	252	4.32	457.07	218.14	190.21
10 (P80-N17)....	4.96	273	1.54	150.40	"	"	13.0	694	6.37	243.35	92.95	-23.51
11 (P80-N18)....	3.36	112	1.11	264.27	"	"	10.2	705	6.69	253.07	-11.20	-13.79
12 (P80-N19)....	5.91	233	1.89	236.27	"	"	14.0	410	7.81	407.999	171.729	141.139
13 (P80-N20)....	4.32	143	1.39	259.20	"	"	14.6	496	8.25	443.47	184.27	176.61
14 (P80-N21)....	5.85	170	1.94	320.0	"	"	13.2	360	6.64	491.72	169.72	224.86
15 (P80-N22)....	4.51	190	1.34	188.0	"	"	17.0	873	9.52	290.67	2.67	-23.81
16 (P80-N23)....	5.31	201	1.57	248.0	"	"	17.4	801	8.87	294.82	46.82	27.96
17 (P100-N2)....	5.03	241	.81	108.27	Oct. 29, '17	Jan. 30 '18	7.4	340	3.5	274.766	166.496	7.906
18 (P100-N3)....	4.05	181	1.07	157.60	"	"	7.4	210	3.5	444.53	286.93	177.67
19 (P100-N4)....	4.08	223	1.22	145.87	"	"	10.0	326	4.31	352.53	206.66	85.67
20 (P100-N5)....	4.06	200	1.04	138.66	"	"	12.8	223	4.66	557.07	418.41	290.21
21 (P100-N6)....	4.25	256	.89	92.53	"	"	14.2	295	6.01	543.40	450.87	276.54
22 (P100-N7)....	5.93	360	1.05	77.599	"	"	10.0	258	4.49	483.99	403.39	217.13
23 (P100-N24)...	4.04	133	.97	194.399	Oct. 31, '17	"	10.6	446	5.7	340.80	146.41	73.94
24 (P108-N5)....	4.04	151	1.19	210.133	"	"	17.2	400	5.81	320.53	110.40	53.67
25 (P108-N6)....	4.02	135	1.42	280.266	"	"	13.0	514	7.10	368.25	87.98	101.39
26 (P108-N17)...	3.79	149	.89	159.199	"	"	13.0	254	6.96	730.67	571.47	463.81
27 (P107-N3)....	5.06	201	1.34	177.59	"	"	13.2	376	7.31	508.40	430.81	241.54
28 (P107-N4)....	3.03	121	.76	167.255	"	"	17.6	460	4.43	256.80	89.55	-10.06
29 (P107-N7)....	5.01	314	1.27	107.733	"	"	13.2	250	7.19	766.93	659.20	500.07
30 (P38-N29)....	2.74	220	.64	77.33	"	"	10.2	418	5.11	325.86	248.53	59.00
		Common Stock.										
					"	"	9.8	401	4.00	266.86		

Oil Yield of Different Strains of Sesamum (Liñga) as Affected by the Season of the Year and the Method of Culture

By CLARO C. SAMONTE

Thesis presented for graduation from the College of Agriculture, No. 91

INTRODUCTION

Sesamum, or *liñga*, is one of the most important oil-yielding plants. This plant has long been cultivated in tropical countries, (1) as well as in Asia, but the exact origin is not definitely known. According to A. de Candolle (2) sesame seed was brought from Sunda Islands

to India several thousand years ago and has migrated thence through the Euphrates basin to Egypt. The plant has long been raised on a small scale in various parts of the Philippines, notably in Pampanga, Tarlac, Pangasinan, etc. The following statistics (7) will further show the importance of the crop.

Place	Year	Area Planted		Ton	Yield Kg.
		Acres	Hectares		
British India.....	1905	4,023,847	1,612,893		
British India, excluding Burma but including the native States of Bombay and Sind..	1905	4,178,700	1,691,781.37	300,400	273,181,818.18

Although it has very limited use in the Philippines, it plays an important part in the industry of some other countries. In France (11) the oil is extracted and used in soap making and in the manufacture of perfume; in India (4) for cooking, anointing, as adulterant of olive oil, as lamp oil and as an India rubber substitute (5).

Because of these various uses, it seems advisable to increase the area in these Islands for the growing of sesamum. Zulaybar (6) says: "As this country grows and as its business improves, both

internally and externally, there is every reason to believe that the demands for sesamum will be proportionally greater and greater and an early study for the purpose of bringing it to its maximum production in the most economical way would certainly be beneficial."

The plant is raised in the Islands at present chiefly for the seed which is used for food and as a condiment, but there seems to be no reason why it could not be profitably grown for oil. The following table shows its high rank as an oil-bearing seed.

TABLE I

Name of Plants	% of Oil	Source of Information
Peanut seed— <i>Arachis hypogaea</i>	40 to 54	H. Ingle, Manual of Agr. Chem. pp. 420-1
Cotton seed— <i>Gossypium herbaceum</i>	20	" " " " " " " "
Flax seed— <i>Linum usitatissimum</i>	40	" " " " " " " "
Castor seed— <i>Ricinus communis</i>	50	" " " " " " " "
Sun flower kernel— <i>Helianthus annus</i> ...	30 to 50	" " " " " " " "
Coconut meat— <i>Cocos nucifera</i>	40 to 64.6	Villyar, Phil. Agr. & For. VI, No. 2-3.
Liñga seed— <i>Sesamum indicum</i>	45.6	Wiesner, Rost. des Pflanzenreiches p. 778.

The oil has different names, (11) viz., til, jinijili, and gingelly. It is also called sesame oil, (1) beneseed oil,

gingelli oil, and teel oil. In America (7) the seeds are sold under the name of "bene".

Preparatory to the introduction of sesamum as a source of oil on a commercial scale, the present work was undertaken for the purpose of determining:

1. The effects of various seasonal conditions on the yield and oil content of sesamum;

2. The effects of different cultural methods on the yield and oil content; and

3. The strains giving the greatest yield of oil under given conditions.

Not one of these factors, as applied to Philippine conditions, has as yet been determined.

ORIGIN OF SEEDS

The seeds for the present investigation were furnished by the Agronomy Department of the College of Agriculture, the following table giving their number, variety names, and origin.

TABLE II
SEEDS USED FOR EXPERIMENT

<i>College No.</i>	<i>Variety</i>	<i>Origin</i>	<i>Introduced by</i>
1622 F ₅	White	Toungoo, Burma	C. C. Bachelder, 25-XI-1916.
6382 F ₂	White	Pekin, China	" 25-XI-1916.
6383 F ₂	White	Manila	S. Flores, "
6384 F ₂	Brown	Manila	" "
6385 F ₂	Black	Manila	" "
326 F ₅	Black	Phil. Exposition, 1912	" "

VARIETY CULTURE, FIRST AND SECOND PLANTING

After the preparation of ground the first planting was made on May 11-12, 1917. Each strain occupied three 50 sq. m. plots which had previously grown tobacco and a few legumes, and *Dioscorea* and *Sorghum*. Each plot in the second planting had an area of about 70 sq. m. The second planting was made on September 19 to 20, 1917. The ground in both plantings was made fine to give a good foothold medium for the small seeds.

METHOD OF PLANTING

The seeds were planted in rows of 50 and 75 cm. apart and when the seedlings were about 10 cm. high, they were thinned out to the distance previously determined, 20 cm., 30 cm. and 40 cm. This gave spacing of 50 x 20 cm., 50 x 30 cm. and 75 x 40 cm. Transplanting were made in places where plants died or when the seeds failed to germinate.

CULTIVATION

The plants were first cultivated when about 5 to 8 cm. high or when there

were 4 to 6 leaves to the plant. By this time, they were strong enough to withstand cultivation. The land was kept free from weeds. Plants were cultivated for the second time when they were about knee high. The plants were cultivated for the last time when they were about to bloom, and, except in small varieties, it was found that at that time the leaves of plants overlapped each other and the land was, therefore, shaded and kept moist. The frequency of cultivation depended upon weather conditions. After the last cultivation care was taken to remove all weeds that may grow among the plants especially vines, which would cause trouble in harvesting. In small strains of sesamum, as was observed in 6382 F₂, the plants could be cultivated even when flowering or when the first capsules were just beginning to form.

TIME OF MATURITY

As was to be expected, some of the varieties matured earlier than others. The following table shows the number

of days from planting to maturity of the various strains in the two plantings:

From the foregoing table it is shown that 6382 F₂ and 1622 F₅ are the early varieties, 326 F₅ and 6383 F₂ the medium early, and 6384 F₂ and 6385 F₂ the latest.

ENEMIES

During the growth of the plants observation as to insect and fungus pests was also made. Both fungi and insects were found to destroy this crop. Damping-off fungus was found to exist especially when the seedlings were crowded and when the ground was too wet. Leaf spot was also found on the stems and capsules, but it exists after the work of insects, mostly Hemiptera. Leaf rollers were found to be fond of eating the leaves of young plants. Larvae of certain moths also fed on young leaves. Of the strains used, 6382 F₂, 1622 F and 326 F₅ were found to be the least susceptible to the attack of the fungus. (*)

The same fungous and insect pests were observed in the second planting and the destruction from them was greater. There were more barren plants in the second planting than in the first. Because of the heavy rainfall during October and part of November, many plants died in the second planting. During the present investigation it was observed that not all the strains used were hardy to the conditions, and that 1622 F₅ excelled all other strains. While in the first planting the writer observed the plants to grow as high as 2.5 m., as in 326 F₅, in the second planting the tallest plant was only 1.2 m. and was also found in 326 F₅. 6382 F₂ was only about 0.5 m. high; in the first planting it grew about 1.3 m. high. In all cases the writer found that the plants in second planting

* The hemipterous pest alluded to in this thesis is probably *Nezara viridula* Linn, an insect of almost world-wide distribution. A common lepidopterous pest of sesamum is a sphinx larva, *Acherontia lachesis* Fabr. The leaf spot mentioned is *Cercospora sesami*.—EDITOR.

TABLE III

College Number	Date Planted		Date Above Ground		Date of Flowering		Date Harvested		No. of days from planting to harvesting	
	1st Planting	2nd Planting	1st Planting	2nd Planting	1st Planting	2nd Planting	1st Planting	2nd Planting	1st Planting	2nd Planting
6382 F ₂ ..	11-V-1917	20-IX-1917	15-V-1917	24-IX-1917	3-VI-1917	11-X-1917	28-VII-1917	7-XII-1917	78 days	77 days
1622 F ₅ ..	11-V-1917	20-IX-1917	15-V-1917	24-IX-1917	29-VI-1917	18-X-1917	8-VIII-1917	10-XII-1917	89 "	80 "
326 F ₅ ..	11-V-1917	19-IX-1917	15-V-1917	24-IX-1917	6-VII-1917	21-X-1917	25-VIII-1917	2-I-1918	106 "	104 "
6383 F ₂ ..	12-V-1917	19-IX-1917	17-V-1917	25-IX-1917	6-VII-1917	24-X-1917	8-VIII-1917	2-I-1918	108 "	104 "
6384 F ₂ ..	12-V-1917	19-IX-1917	17-V-1917	25-IX-1917	6-VII-1917	24-X-1917	20-VIII-1917	5-I-1917	131 "	107 "
6385 F ₂ ..	12-V-1917	19-IX-1917	17-V-1917	25-IX-1917	6-VII-1917	24-X-1917	20-VIII-1917	5-I-1917	131 "	107 "

were shorter and more branchy than in the first planting.

In order to facilitate the comparative study of the effects of season and spacing

upon the growth of these plants the following data both from first and second plantings are combined in the table below:

TABLE IV
EFFECTS OF SEASON AND SPACING UPON THE GROWTH OF SESAMUM

College Number	Spacing	No. of Plants Planted		No. of Plants Maturing		% of Maturing Plants	
		1st Planting	2nd Planting	1st Planting	2nd Planting	1st Planting	2nd Planting
6382 F ₂	50 x 20 cm.	451	591	449	580	99.5	98.1
	50 x 30	318	415	316	306	99.3	73.7
	75 x 40	162	230	160	225	98.7	97.9
1622 F ₅	50 x 20	454	564	453	501	99.7	88.9
	50 x 30	321	432	319	429	99.4	99.3
	75 x 40	166	231	166	207	100.0	89.6
326 F ₅	50 x 20	453	616	449	593	99.1	96.2
	50 x 30	319	413	17	359	5.3	86.9
	75 x 40	162	224	162	208	100.0	92.8
6383 F ₂	50 x 20	453	561	453	497	100.0	88.6
	50 x 30	320	421	320	369	100.0	87.6
	75 x 40	163	229	158	212	96.9	92.5
6385 F ₂	50 x 20	453	560	450	487	99.3	86.9
	50 x 30	319	419	316	394	99.0	93.8
	75 x 40	164	207	162	188	98.7	90.8
6384 F ₂	50 x 20	454	564	450	504	99.1	89.3
	50 x 30	320	423	317	379	99.0	89.5
	75 x 40	162	211	147	197	90.7	93.3

By the fact that there were more barren plants in the second planting than in the first, it is evident that the percentage of maturing plants in the first will generally be higher than in the second. And it is only in two cases, namely, 326 F₅ at a spacing of 50 x 30 cm., first planting, and 6384 F₂ spacing 75 x 40 cm., first planting, that the second planting excelled the first. This brings out the importance of planting this crop at the beginning of the dry season.

HARVESTING AND METHOD OF SEED EXTRACTION

To prevent loss of the seeds the crop was harvested when the majority of the capsules were mature but not yet opened. A bolo was used for cutting. Sickles, knife and pruning shears may also be used. The stems were cut at

the last branch bearing capsule so that the drying was easier than if the whole plant were cut close to the ground. As soon as the stems were cut they were carried to the seedhouse and spread on pandan mats. The use of mats is recommended because they can be easily transferred from place to place which is especially desirable at times when rain comes without warning. The length of time required to dry the capsules depends on weather conditions, but if the sun shines brightly the capsules open in from 4 to 6 days. In drying the capsules, different strains should be put far apart in order to avoid the mixing of seeds. The capsules on opening throw the seeds sometimes about one meter away from the pile. After the capsules had opened, the pile was beaten with a piece of wood with occasional shaking and turning. The seeds were easily separated from the dried,

crushed leaves and broken capsules and stems with bamboo sieves and were then winnowed and cleaned. After the seeds had been cleaned, they were further dried in the sun for 2 or 4 days to prevent rotting.

DETERMINATION OF MOISTURE

Ten grams of the clean seeds from each sample were dried to constant weight in the water oven and weighed. The loss of weight calculated in per cent of cleaned seed is given in Table V.

TABLE V
PERCENTAGE OF MOISTURE

College Number	50×20 centimeters		S P A C I N G				75×40 centimeters		Average	
	1st		50×30 centimeters		75×40 centimeters		1st		Planting	
	Planting	2nd Planting	1st Planting	2nd Planting	1st Planting	2nd Planting	Planting	2nd Planting	1st	2nd
6382 F ₂	5.39%	6.16%	5.05%	6%	6.03%	4.96%	5.49	5.70		
1622 F ₅	7.84	6.76	7.16	7.85	7.08	7.95	7.36	7.52		
326 F ₅	10.95	9.61	11.85	9.74	11.7	9.29	11.5	9.55		
6383 F ₂	6.92	7.02	6.82	7.14	6.89	6.97	6.84	7.04		
6385 F ₂	11.85	9.94	9.72	9.03	10.03	9.58	10.53	9.51		
6384 F ₂	9.48	8.96	8.73	8.45	9.26	7.89	9.49	8.43		

It can be seen from the above table that the percentage of moisture in the second planting is generally less than that in the first.

OIL EXTRACTION AND YIELD OF OIL

In the determination of oil, duplicate samples of 2 grams of the dried seed were used. These were finely ground in a porcelain mortar. Oil was extracted in a locally constructed extractor holding 18 samples at a time. The per cent of oil was determined by difference, that is, the loss in weight

after extraction with chloroform is the amount of oil that could be secured from the seed. The oil may also be extracted from the seeds by the use of ether or pressure (9).

The length of time required for extraction of oil depends on the efficiency of the apparatus, heat applied, and the degree of fineness in grinding the seeds. The usual length of time to extract the oil is from 8 to 10 hours. The yield of oil obtained by the process described above is given in percentage of the dried seed in Table VI.

TABLE VI
PERCENTAGE OF OIL AS AFFECTED BY SPACING AND SEASON

College Number	50×20 centimeters				S P A C I N G							
	1st Planting				50×30 centimeters				75×40 centimeters			
	2nd Planting				1st Planting				2nd Planting			
6382 F ₂ ...	%	Ave.%	%	Ave.%	%	Ave.%	%	Ave.%	%	Ave.%	%	Ave.%
	54.27	56.71	52.32	52.76	54.81	53.96	50.02	49.83	53.13	52.52	48.93	50.1
1622 F ₅ ...	59.16		53.2		53.12		49.64		51.92		51.28	
	41.11	42.14	41.45	41.88	50.02	49.53	42.69	43.21	47.18	47.23	42.4	43.72
326 F ₅ ...	43.17		42.31		49.04		43.94		47.29		45.05	
	41.06	40.1	40.12	38.90	39.33	39.21	41.91	41.2	41.46	41.48	39.04	37.74
6383 F ₂ ...	39.14		37.69		39.10		40.5		41.50		36.44	
	31.67	30.28	35.3	30.1	38.92	38.38	31.42	30.63	22.0	22.09	30.67	31.08
6385 F ₂ ...	28.9		34.91		37.84		29.85		22.19		31.5	
	29.72	29.86	24.46	26.09	33.68	32.91	30.11	28.14	24.87	24.97	27.19	28.16
6384 F ₂ ...	30.0		27.72		32.14		26.18		25.07		29.14	
	28.56	27.35	30.15	28.64	25.44	23.32	26.8	28.12	30.4	29.22	21.17	21.67
	26.14		27.14		21.2		29.44		28.05		22.18	

From the preceding table it can be seen that 6382 F₂ excelled all other strains in the content of oil; that 50 x 30 cm. spacing seems to be the optimum spacing for this strain; for 6382 F₂, 1622 F₅, 6383 F₂ and 6385 F₅, 326 F₂ and 6384 F₂ thrive well at 75 x 40 cm. and this spacing for them gave the highest per cent of oil.

It is said that under conditions of ordinary farming climate is a more potent factor than soil in modifying the size of seed and its oil content, probably because the conditions of the atmosphere which constitute the climate largely control the corresponding conditions

of the soil. (10) "The most probable explanation is that the atmosphere is subject to greater and more rapid variations in moisture and particularly in temperature, and also that the 'soil climate' is greatly influenced by the weather conditions."

Various tests on soy beans, peanut and sunflower were carried out under a wide range of soil types and climatic conditions by W. W. Garner, H. A. Allard and C. L. Foubert and the results, as a whole, emphasize the fact that the relative effects of different soil types are not specific and constant, but depend largely on seasonal conditions.

TABLE VII
YIELD OF SEEDS AND OIL AS AFFECTED BY SPACING AND SEASON

College Number	Spacing	Yield of good seeds from area planted in gm.		Computed yield of good seeds per Ha. in kg.		Computed yield of oil per hectare in kg.	
		1st Planting	2nd	1st Planting	2nd	1st Planting	2nd
6382 F ₂	50 x 20 cm.	2745.95	1340	549.19	191.42	268.7	94.77
	50 x 30	3951.0	2231	790.20	318.71	404.86	148.43
	75 x 40	1282.0	1109	256.4	158.43	126.54	75.41
1622 F ₅	50 x 20	1260	1720	252	245.71	98.84	95.84
	50 x 30	2882	2593	576.4	370.43	265.05	147.5
	75 x 40	2568.2	1170	513.74	167.14	225.46	65.69
326 F ₅	50 x 20	1131	1520	226.2	217.14	80.77	76.15
	50 x 30	— *	2450	— *	350	— *	130.15
	75 x 40	1134	1800	226.6	257.14	82.99	88.03
6383 F ₂	50 x 20	1906	998	381.2	142.57	107.44	39.9
	50 x 30	2142.5	1512.9	428.5	216.13	153.24	61.47
	75 x 40	1714	508.8	342.8	72.68	70.51	20.99
6385 F ₂	50 x 20	1030	974.2	206	139.17	54.22	32.70
	50 x 30	1670	1676	334	239.43	99.24	61.29
	75 x 40	1150	564.1	230	80.59	122.67	20.51
6384 F ₂	50 x 20	1115	1161.3	223	165.9	55.92	43.45
	50 x 30	1020	1364	204	194.91	42.84	50.18
	75 x 40	475	610.7	95	87.24	25.19	17.41

* Omitted because of exceptionally poor stand of plants.

It is evident that those varieties in Table VI yielding high percentage of oil are also the ones which gave the highest yield of seeds; that 6384 F₂ is the poorest. Different strains seem to adapt themselves to different spacings; 326 F₅ being a big variety prefers 75 x 40 cm. spacing, while 1622 F₅, 6382 F₂, 6383 F₂ and 6385 F₂ thrive well at a spacing of 50 x 40 cm. and 6384 F₂ at 50 x 20 cm. The larger and more branchy the plant is, other things being equal,

the greater is the space it will occupy and consequently the fewer the plants per given unit of area. By referring to Table III it seems that early maturing quality has some relation to the yield. The strain earliest to mature gave the greater yield as exemplified by 326 F₅, 1622 F₂. The best yielders at the first planting were also the best at the second, but the yield from the later planting was generally less. As a matter of common belief, the greater the absorption area for

a plant during the period of growth, the greater would be its chance of getting plant food and up to a certain point the greater the yield. The treatment on both was practically identical so that any difference in the yield of seed and oil that may arise between the two plantings can be attributed to the effect of season. Because of better yield, both of seed and oil in the first planting than in the second, it seems preferable to plant the crop at the beginning of the dry season to escape the latter unfavorable condition.

PROPERTIES OF THE OIL

The oil of all varieties is odorless, but, when treated with dilute hydrochloric acid, gives an odor similar to that of roasted peanut. The oil from the white varieties, 1622 F₅, 6382 F₂, and 6382 F₂, is light yellow, while that of the black is of an amber color. The oil keeps well and does not easily become rancid.

Different observers differ in opinion as to the saponification and the iodine-absorption numbers, the average being 191.02 and 107.9, respectively. The writer found the saponification number of the oil to be 188.57. According to Farnsteiner, sesame oil contains 78.1% oleic and linolic acids. According to

Utz, this oil is dextro-rotatory and its being optically active is due to the presence of phytosterol and sesamin, the latter being a resinous substance, which has the formula, C₁₈ H₁₈ O₆. The drying power of the oil is much less pronounced than that of cotton-seed oil. In the Levache test, after 7 days, only 2.4% of oxygen were absorbed (5).

SUMMARY AND CONCLUSIONS

Sesamum indicum, līnga, is a promising crop as a source of oil. This plant could be harvested at from 78 days for the early varieties to about 140 days for the late, from the time of planting. Of all the varieties under culture at the college, only a few adapted themselves to the given conditions. Of the 6 strains used, 6382 F₂ gave the highest per cent of oil and yielded best at 50 x 20 cm. spacing. The destruction during the rainy-season was greater than during the dry-season planting and for this reason the oil content, as well as the yield of seed, was generally higher in the latter. The earliest maturing strain was found to give the highest yield of oil. 50 x 30 cm. spacing seems to give the best results on larger strains.

The following table shows that it pays to raise this crop during the dry season.

TABLE VIII
COMPARATIVE VALUE OF OIL AND SEEDS PER HECTARE IN BOTH PLANTINGS

College Number	Kg. of seed per Ha. Planting		Kg. of Oil per Ha. Planting		V a l u e			
	1st	2nd	1st	2nd	Of Seed Ha.		Of Oil Ha.	
					1st Planting	2nd Planting	1st Planting	2nd Planting
6382 F ₂	531.93	222.85	266.7	107.87	P64.15	P28.97	P513.70	P222.5
1622 F ₅	447.35	261.09	361.19	103.34	58.20	46.95	280.80	213.2
326 F ₅	226.5	274.76	81.88	98.11	29.43	35.72	156.70	202.4
6383 F ₂	384.1	143.79	110.39	40.76	49.93	18.69	227.7	85.0
6385 F ₂	256.6	153.06	92.04	38.18	33.36	19.90	190.0	68.8
6384 F ₂	174	149.33	41.31	37.01	22.62	19.42	85.2	76.3
Ave.....					P42.78	P28.27	P225.68	P145.20

Considering the value of seed as the net profit, then the first planting will bring more money to the farmer than the second. The value of oil in the first

planting was P225.68, as against P145.20 in the second. When the materials for oil extraction are cheap and handy, it is better to sell the crop in the form of

oil than seed. By selling the crop in the form of oil the farmer can utilize the by-product, oil-cake, for other purposes, such as feed for hogs, horses, as fertilizer, etc. As to the return per unit of area, the strains used are arranged in the table in the order of their relative value, the last one in the list being the variety that gives the lowest profit to the farmer. The value of the seed is ₱.13 per kilo. (11).

RECOMMENDATIONS

Rainy weather, especially if accompanied by wind, is not favorable to the formation of a good stand of this plant. Moist atmosphere during the period of growth is favorable and at harvest time sunshiny weather is preferable. Cultivation is, indeed, beneficial to the plant. Thinning while the plants are still young is recommended. Although transplanting is possible, plants to be transplanted should not be very old, otherwise they suffer much from the damage done to the roots. Deep planting of the seed is not advisable for there is a greater chance for them to rot than to germinate. About one inch is good depth for planting the seeds. At this depth, it will be found that germination will be vigorous and quite uniform.

Seeds can be planted either broadcast or in hill. There are one or two advantages in planting the seeds in hill. It facilitates cultivation. Less seed is required per unit of area than is the case when broadcast planting is practiced.

Ground intended for sesamum should be well pulverized because the seeds are small. Extensive area should be given to it.

ACKNOWLEDGMENT

The writer expresses his obligations to Assistant Professor I. Elayda and to Associate Professor F. W. Ashton for their suggestions during the progress of the work and preparation of this paper.

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COLLEGE NOTES

The total enrolment in this college for the year 1918-1919 is 356, as against 550 last year. The decrease is mainly due to the raise in entrance requirements to the completion of the second year, high school, and the discontinuance of the two-year high-school course of the college.

General Emilio Aguinaldo, accompanied by President Villamor and Miss Carmen Aguinaldo, paid a visit to the college recently.

Dr. W. H. Weston is investigating the downy mildew of corn (*Sclerospora maydis*), and not the powdery mildew, as was erroneously reported in the preceding issue of this paper. "Powdery mildew of corn", so far as known, does not exist.

Preliminary work on the dormitory houses for the accommodation of students on the college campus has been begun.

Influenza, an epidemic which recently broke out in Manila, was brought from that source by some of the students of the college. The disease was fortunately of only a very restricted distribution here.

The Board of Regents of the University, in its meeting of June twentieth, approved the following changes in the personnel of the College of Agriculture: *New appointments*—Faustino Q. Otones, '18, assistant in botany, effective on the first day of duty; José P. Esguerra, '18, assistant in animal husbandry, effective June first; Ramon V. Manio and Nemesio Catalan, assistants in agronomy, effective on the first day of duty; José L. Marfori, farm foreman, effective on the first day of duty; Isaias

Maclang, teacher in carpentry, effective June seventeenth; and Albino Vidal, teacher in blacksmithing, effective June twenty-seventh. (The appointments of Mauricio David and Prudencio Ruiz, which were noted in the preceding issue of this paper, were cancelled). *Promotions and transfers*—Leopoldo B. Uichanco, from assistant in entomology to instructor, effective July first; Elias H. Pañaniban and Leopoldo S. Clemente, assistants in agronomy, to assistants in chemistry and in the experiment station, respectively, with increase in compensation, effective July first; Sotero F. Albano, from assistant in mathematics to assistant in agronomy, with increase in compensation; Gerardo O. Ocfemia, from assistant in botany to assistant in plant pathology under the experiment station; Fernando D. Luistro, from assistant in agronomy to assistant in the experiment station.

Mr. Pedro Montellano, '15, assistant in chemistry since his graduation from this college, resigned in order to accept a position with the Bureau of Education as principal of the Boac Intermediate-High School.

Mr. Eligio C. Cruz, clerk in the office of the dean, tendered his resignation, effective June third, in order to accept a position in a commercial house.

Rinderpest has reappeared in Los Baños and vicinity, and quarantine has been declared on the college grounds.

The month ended with a typhoon of two days' duration, which did considerable damage to the students' and faculty houses and destroyed over fifty per cent of the culture on the college farm and experimental plots.

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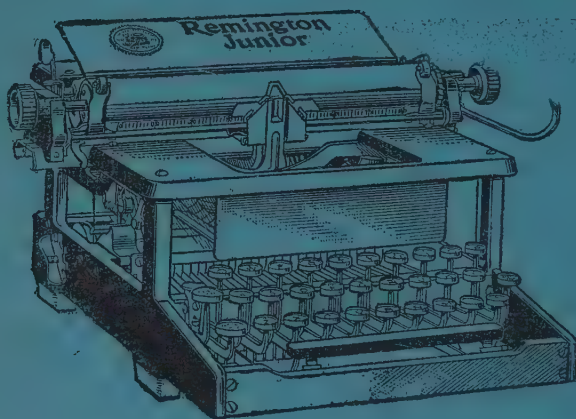
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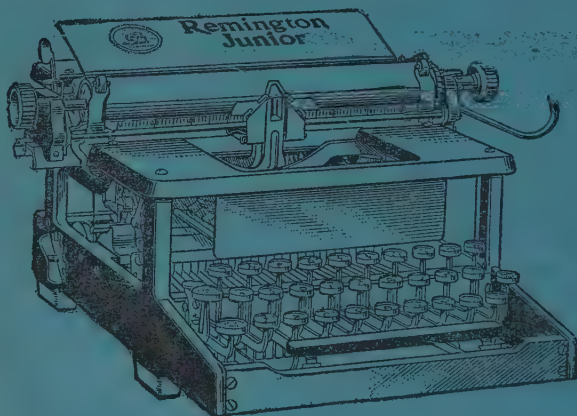
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